

# THE DAILY RHYTHM OF HAWK MIGRATION AT CEDAR GROVE, WISCONSIN

HELMUT C. MUELLER AND DANIEL D. BERGER

TABOR (1956) has shown that captive Common Buzzards and Rough-legged Hawks show activity rhythms under various experimental light regimes. Laboratory experiments by Mueller (1972) have shown that the American Kestrel or Sparrow Hawk has a circadian rhythm in hunger and predatory behavior that peaks in the late afternoon, while the Broad-winged Hawk shows no peak, or perhaps a slight peak in the morning. Subjective impressions gained from many autumns of watching migration suggested to us that accipiters were more commonly seen in the morning while buteos and falcons occurred later in the afternoon. We also felt that all species, except perhaps falcons, were easier to lure into traps in the morning, suggesting that hunger is at a peak early in the day. In this paper we subject these impressions to rigorous analysis.

## METHODS

The data were collected in the autumns of 1958 through 1961 at the Cedar Grove Ornithological Station. More years of data were available, but in view of the tremendous labor involved in extracting the information from our field notebooks, we felt that 4 years of records were adequate to establish the points made in this paper. The station is on the western shore of Lake Michigan about 60 km north of Milwaukee, Wisconsin. A detailed description of the region can be found in Mueller and Berger (1966) and of observational and trapping techniques in Mueller and Berger (1961, 1967b, 1970) and Bub (1968). Observation and trapping were generally conducted from dawn to dusk, although attention to both was often sporadic on days with little or no migration. We watched on most days between 30 August and 25 October; occasionally as early as 14 August and as late as 30 November. Few days with a good migration were missed; within the months of September and October, when most of the migration occurs, we watched on essentially every day when the weather conditions were at all favorable for migration. The 198 days of observation during the four autumns thus constitute a reasonably complete census of the hawk migration.

Each hawk seen was identified to species whenever possible; fewer than 1 percent could not be identified at least to genus. Whenever possible the time of passage or capture of each bird was recorded to the nearest minute; occasionally the amount of activity overwhelmed us and we were somewhat less exact.

## RESULTS AND DISCUSSION

Table 1 presents the observations totalled for 1-hour intervals (e.g. 05:00-05:59) in terms of percentages of the total number of birds seen for all hours and all days. Temporal distribution varied little among members of a genus except that the Broad-winged Hawk is clearly aberrant. This species showed two peaks, one at 09:00 and 10:00 and one at 16:00.

TABLE 1  
HOURLY DISTRIBUTION OF MIGRATING HAWKS AT CEDAR GROVE, AUTUMNS 1958-1961<sup>1</sup>

Species	n	Hour (CST)														
		5	6	7	8	9	10	11	12	13	14	15	16	17		
Turkey Vulture	29			3	10	17	7	7	10	24	21					
Marsh Hawk	828	1	3	8	20	13	13	12	11	9	5	4	1			
Sharp-shinned Hawk	4,433		2	10	15	16	13	11	10	10	6	4	2			
Cooper's Hawk	128		2	5	11	17	19	13	9	12	6	3	2	1		
Goshawk	26			4	15	8	23	15	4	8	8	8	4	4		
Unidentified accipiter	15		7	20	20			7		7	7	13	7	7	7	
Red-tailed Hawk	1,949			1	5	19	27	16	13	8	6	5				
Red-shouldered Hawk	135			1	7	24	22	22	18	3	2	2				
Swainson's Hawk	3				33				67							
Broad-winged Hawk	2,391			2	37	28		3	3	4	6	16				
Rough-legged Hawk	149			1	12	19	17	20	9	6	3	12				
Unidentified buteo	81			1	6	9	20	26	19	7	6	4	3			
Peregrine	109		1	1	7	7	10	13	15	17	15	7	6	2		
Pigeon Hawk	482			1	4	8	7	11	12	13	20	13	7	1		
Sparrow Hawk	304	1		7	9	11	5	7	15	16	11	12	5	3		
Unidentified falcon	76			1	3	3	4	16	11	12	20	25	4	3		
Osprey	110	1	3	7	6	10	13	11	11	8	11	9	9	2		
Bald Eagle	13				15	8	15	23	15	15		8				
Golden Eagle	3				33		33				33					

<sup>1</sup> The figure given for each hour interval (e.g. 05:00-05:59) is the percent of the total observed (n).

Over 96 percent of the birds contributing to the 09:00 peak and 94 percent of those contributing to the 10:00 peak were seen on one day, 16 September 1961. Similarly, 92 percent of the birds contributing to the 16:00 peak were seen on a single day, 15 September 1961. As hawk movements are strongly influenced by weather (Mueller and Berger 1961, 1967b) and Broad-winged Hawks tend to occur in large flocks, this is a strongly biased sample and more years of data should be analyzed to determine the mean temporal pattern for this species. No other species occurs as irregularly and in anything approaching as large a flock as do the Broad-wings; we strongly suspect that 10 or 20 years of data would reveal that their temporal pattern is similar to that of other buteos.

Although the temporal pattern shows little variation within a genus, it differs considerably between genera. In Figure 1 we have pooled the data for all species in each of the genera *Accipiter*, *Falco*, and *Buteo* omitting the Broad-winged Hawk. The three curves show distinctly different peaks, with *Accipiter* occurring most commonly between 08:00-09:59, *Buteo* at 10:00-10:59, and *Falco* between 13:00 and 14:59. These results generally fit with our subjective impressions, although we expected a more pronounced early peak for *Accipiter*, and the relatively early peak for *Buteo* is a surprise.

Only two species outside the above three genera were seen with sufficient frequency to permit comment on their temporal occurrence. The Harrier

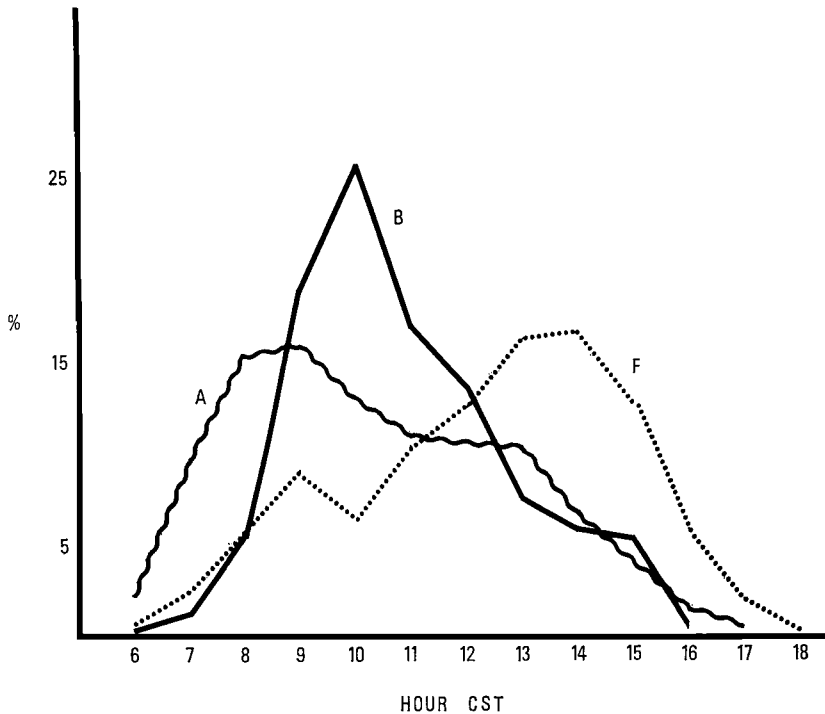


Figure 1: Hourly distribution of the migration of *Accipiter* (wavy line,  $n = 4,602$ ), *Falco* (dotted line,  $n = 987$ ) and *Buteo*, less the Broad-winged Hawk (solid line,  $n = 2,317$ ). The value for each hour interval (e.g. 06:00–06:59) is the percent of the total observed.

or Marsh Hawk shows a peak at 08:00–08:59 and the Osprey appears to occur with about equal frequency throughout the hours between 07:00 and 16:59.

We have long had the impression that diurnal raptors, with the exception of falcons, were easier to trap in the morning than later in the day. Our expectations are not met by the data; if one considers sample sizes and variations, all species are as easy to trap at any given time of day as any other (Table 2). This suggests that there is no temporal variation in hunger and contradicts Mueller's (1972) findings, though Mueller's experiments were performed under controlled deprivation schedules and with limited access to food. The deprivation intervals of hawks in the wild were variable and food was variably available throughout the day, a situation that may have completely obscured any underlying rhythm in hunger.

The functional or adaptive significance of the differences in peaks of activity remains a question. We can see no clear correlation with the

TABLE 2  
HOURLY DISTRIBUTION OF TRAPPING PERCENTAGE AT CEDAR GROVE, AUTUMNS 1958-61<sup>1</sup>

Species	n	Hour (CST)											
		6	7	8	9	10	11	12	13	14	15	16	17
Marsh Hawk	36		6	5	7	4	5		3	8	7		
Sharp-shinned Hawk	557	9	13	12	14	14	11	11	12	12	12	16	40
Cooper's Hawk	38	67	50	43	27	25	44		20	50	25		
Goshawk	16			75	100	50	75	100			100	100	100
Red-tailed Hawk	195		4	20	11	7	10	12	9	14	11	17	
Red-shouldered Hawk	9			11	9	3		4	25		33		
Rough-legged Hawk	8			17	7		3		11	25			
Peregrine	33		100		25	27	14	56	22	31	50	33	50
Pigeon Hawk	105			24	30	30	22	14	18	25	24	21	
Sparrow Hawk	23		5	4	19	7	5	7	9	3	14		

<sup>1</sup> The figure given for each hour interval (e.g. 06:00-06:59) is the percent trapped of those birds seen during that hour. No birds were trapped prior to 06:00; no Swainson's Hawks or Bald Eagles were trapped; only one Turkey Vulture, one Broad-winged Hawk, and one Golden Eagle were trapped (these are not listed in the table).

migrants' utilization of updrafts. Falcons probably use updrafts least of the three genera, yet they migrate at a time of day when updraft production should be at a maximum; buteos probably depend on updrafts more than the other genera, yet the birds show a distinct peak in migration in the morning when updraft production is probably less than later in the day. There is some correlation between the migratory activity of falcons and buteos and the circadian rhythms of hunger and predatory behavior Mueller (1972) found in laboratory experiments. Perhaps migratory, and other, activity is correlated with hunger, although this merely changes the question to the adaptive significances of differences in rhythms of hunger. Our failure to find any evidence for a rhythm in hunger in our trapping data might lead some to question even this correlation.

The patterns of migratory activity indicated by this paper may be the result of a combinatorial effect of activity, leading lines, wind drift, and various aspects of flight behavior (see Mueller and Berger, 1967a). Thus we might be measuring, in part, the tendency for a bird to follow a leading line as a function of the time of day. We were unable to find quantitative data published on the temporal distribution of migration at other locations. Allen and Peterson (1936) state "The bulk of the Sharp-shins fly in the morning from 7:30 to noon" and that "Pigeon Hawks fly more in the afternoon than do other hawks at Cape May." These qualitative remarks are in general agreement with our data from Cedar Grove. At Hawk Mountain, Broun (1939, 1948) states that the majority of Sharp-shinned Hawks "always come during the afternoon," a qualitative observation that is in disagreement with both Cape May and Cedar Grove. A mountain ridge differs in leading-line characteristics from a lakeshore or peninsula (Mueller and Berger 1967a), and this might result in different temporal

distribution of concentrations of accipiters along the different types of leading lines. Further quantitative data from a variety of localities might be enlightening.

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#### SUMMARY

The autumnal migration of accipiters peaks in the early morning, that of buteos in late morning, and that of falcons in early afternoon. Harriers have an early peak, and Ospreys show no peak. The trapping percentage of all species varies little through the day, suggesting that there are no peaks in hunger.

#### Appendix. Scientific names of birds cited in text.

Turkey Vulture	<i>Cathartes aura</i>
Harrier or Marsh Hawk	<i>Circus cyaneus</i>
Sharp-shinned Hawk	<i>Accipiter striatus</i>
Cooper's Hawk	<i>Accipiter cooperii</i>
Goshawk	<i>Accipiter gentilis</i>
Common Buzzard	<i>Buteo buteo</i>
Red-tailed Hawk	<i>Buteo jamaicensis</i>
Red-shouldered Hawk	<i>Buteo lineatus</i>
Swainson's Hawk	<i>Buteo swainsoni</i>
Broad-winged Hawk	<i>Buteo platypterus</i>
Rough-legged Hawk	<i>Buteo lagopus</i>
Peregrine	<i>Falco peregrinus</i>
Merlin or Pigeon Hawk	<i>Falco columbarius</i>
American Kestrel or Sparrow Hawk	<i>Falco sparverius</i>
Osprey	<i>Pandion haliaetus</i>
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Golden Eagle	<i>Aquila chrysaetos</i>

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*Department of Zoology, University of North Carolina, Chapel Hill, North Carolina 27514, and Cedar Grove Ornithological Station, Route 1, Cedar Grove, Wisconsin 53013. Accepted 7 August 1972.*